MARATHON ELECTRIC INDUCTION GENERATOR

SINGLE BEARING DESIGN

Installation, Operation, and Maintenance Manual

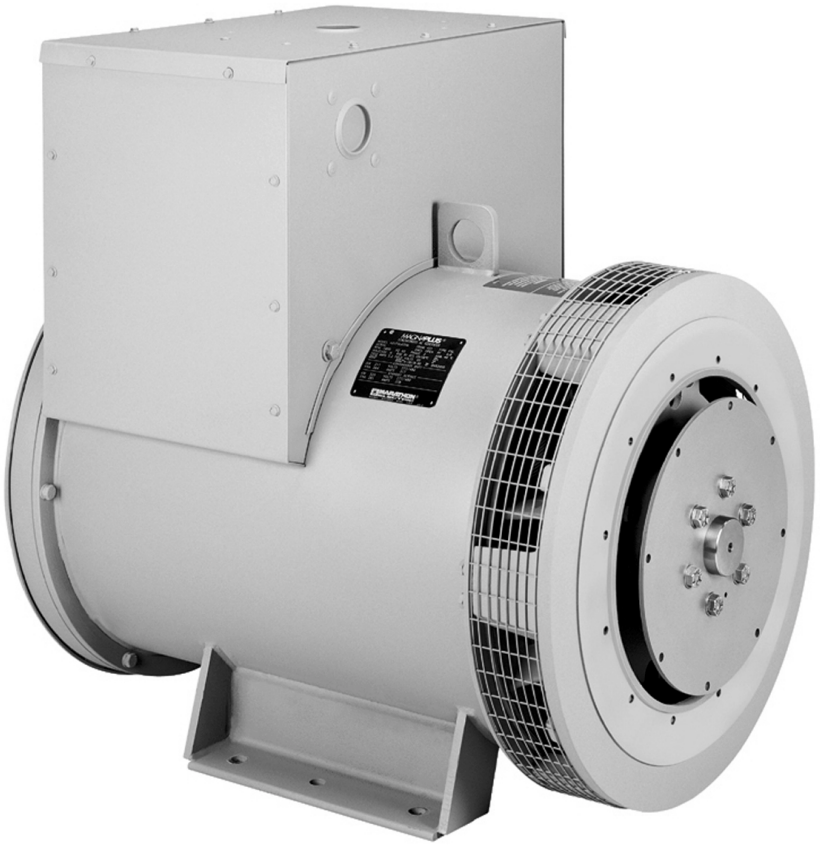

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TABLE OF CONTENTS

SAFETY 2

RECEIVING AND STORAGE 2

UNPACKING AND HANDLING 2
PREPARATION FOR USE 3
ENVIRONMENTAL CONSIDERATIONS 3
ELECTRICAL CONNECTIONS 3
DIRECTION OF ROTATION 3
ALLOWABLE VOLTAGE & FREQUENCY RANGE . 3
GENERATOR MOUNTING 3
END PLAY TESTING 4
TORSIONAL VIBRATION 4

OPERATION 4

PRE-START INSPECTION 4
START-UP 5
SHUTDOWN PROCEDURE 5

MAINTENANCE 5

DRYING WINDINGS 5
Space Heaters 6
Forced Air 6

TESTING 6

VISUAL INSPECTION 6
INSULATION TEST 6

SERVICE 6

BEARING REMOVAL 6
Opposite Drive End Bearing Bracket Removal . . 6
Bearing Replacement 6

RETURNED GOODS 6

TROUBLESHOOTING 7

SAFETY

PLEASE REMEMBER SAFETY FIRST. If you are not sure of the instructions or procedures contained herein, seek qualified help before continuing.

This service manual emphasizes the safety precautions necessary during the installation, operation, and maintenance of your generator. Each section of this manual has caution and warning messages. These messages are for your safety and the safety of the equipment involved. If any of these cautions or warnings is not readily understood, seek clarification from qualified personnel before proceeding.

Before any service work is done, disconnect all power sources and lock out all controls to prevent an unexpected start-up of the generator set driver. Proper grounding (earthing) of the generator frame and distribution system in compliance with local and national electrical codes and specific site requirements must be provided. These safety precautions are necessary to prevent potential serious personal injury or even death.

The hazards associated with lifting or moving your generator are pointed out in the installation and maintenance sections. Incorrect lifting or moving can result in personal injury or damage to the unit.

Prior to start-up of the unit, ensure that all generator leads are properly connected. Always assume that there will be voltage present at the generator terminals whenever the generator's shaft is rotating and proceed accordingly. Caution must be exercised or serious injury or death can result.

This manual is not intended to be a substitute for properly trained personnel. Installation and repairs should only be attempted by qualified, trained people. The cautions and warnings point out known conditions and situations that are potentially hazardous. Each installation may well create its own set of hazards.

When in doubt, ask. Questions are much easier to handle than mistakes caused by a misunderstanding of the information presented in this manual.

RECEIVING AND STORAGE

RECEIVING AND STORAGE

Upon receipt of the generator, it is recommended that it be carefully examined for possible shipping damage. The generator was given to the freight carrier in good condition; thus, the carrier is responsible for the product from the factory dock to the destination. Any damage should be noted on the freight bill before accepting the shipment. Any claims for damage must be promptly filed with the delivering carrier.

In the event that the generator is not immediately installed on its prime mover, it is recommended that the unit be stored indoors in a clean, dry area, which is not subject to rapid changes in temperature and humidity. If the generator is stored for a long period of time, the generator should be tested, cleaned, and dried as required before being put into service. See the maintenance section of this manual for further information. If the unit has been stored in an area where it has been subject to vibration, it is recommended that the bearing(s) be inspected and replaced as necessary.

UNPACKING AND HANDLING

Carefully read all instruction tags shipped with the unit. When lifting, attach an overhead crane to the lifting lug(s) on the generator frame. Apply lifting forces in a vertical direction. When transporting single bearing generators, the

generator's rotor must be adequately supported to prevent damage.

WARNING

THE LIFTING LUG(S) ON THE GENERATOR ARE DESIGNED TO SUPPORT THE GENERATOR ONLY. DO NOT LIFT A COMPLETE GENERATOR AND DRIVER ASSEMBLY BY MEANS OF LIFTING LUG(S) ON THE GENERATOR. PERSONAL INJURY OR EQUIPMENT DAMAGE MAY RESULT.

PREPARATION FOR USE

Although the generator has been carefully inspected and tested in operation prior to shipment from the factory, it is recommended that the generator be thoroughly inspected. Check all bolts for tightness and examine the insulation on lead wires for chafing prior to proceeding with installation. Remove all shipping tapes, bags, skids, and rotor support blocking.

Never start a generator that has been wet without having it thoroughly dried. See the appropriate section of this manual for proper insulation testing and drying procedures.

ENVIRONMENTAL CONSIDERATIONS

The generator is designed for heavy-duty industrial applications; however, dirt, moisture, heat, and vibrations are enemies of rotating electrical machinery. Excessive exposure to the elements may shorten generator life. The temperature of the cooling air entering the intake openings of the generator should not exceed the ambient temperature shown on the generator's nameplate. Generators intended for outdoor application should be protected with housings having adequate ventilation. Although the standard insulation systems are moisture and humidity resistant, space heaters are recommended for extreme conditions. If the generator is to be installed in an area where blowing sand and dust are present, the enclosure should be fitted with filters. Filters reduce erosion on the generator's insulation by blocking high velocity abrasive particles generated by the flow of cooling air through the generator. Consult the factory for appropriate filters and generator deratings required.

ELECTRICAL CONNECTIONS

1. All wiring, fusing, and grounding must comply with the National Electrical Codes and local requirements.
2. To determine proper wiring, rotation, and voltage connections, refer to the information and diagram on the nameplate, separate connection plate, or decal provided.
3. Use the proper size of line current protection and generator controls as required by the National Electrical Code and local codes.

WIRING CONNECTIONS

Wiring of the generator and accessories should be done in accordance with good electrical practices. Follow government, industry, and association standards.

Refer to the connection diagram supplied with the generator and/or the proper diagrams shown in this manual. Install all inter-component and external wiring in accordance with national and local electrical codes.

DIRECTION OF ROTATION

Three Phase

The direction of rotation (phase sequence) should match the rotation of the prime mover. To reverse rotation reverse leads on any two phases.

ALLOWABLE VOLTAGE AND FREQUENCY RANGE

If the voltage and frequency are operated in the following ranges, the generator will operate, although with different characteristics than obtained with the correct nameplate values.

1. Voltage: Within 10% above or below the value stamped on the nameplate.
2. Frequency: Within 5% above or below the value stamped on the nameplate.
3. Voltage and Frequency combined: Within 5% above or below the values stamped on the nameplate.

GENERATOR MOUNTING

WARNING

DISABLE AND LOCKOUT ANY ENGINE CRANKING DEVICES BEFORE ATTEMPTING TO INSTALL OR SERVICE THE GENERATOR. FOR ELECTRIC START SETS, DISCONNECT THE CRANKING BATTERY. FOR AIR START, DISCONNECT THE AIR SUPPLY. FOR MOTOR GENERATOR SETS, OPEN THE POWER SUPPLY TO THE DRIVE MOTOR. FAILURE TO COMPLY WITH THESE SAFETY PROCEDURES COULD RESULT IN SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE.

Single bearing units are provided with an SAE flywheel housing adapter flange and flexible drive discs. Coupling the shaft of the generator to the engine flywheel is accomplished with special steel drive discs bolted to the shaft. In addition to the drive discs, there may be a hub spacer, spacer discs, or a combination of hub spacer and spacer discs inserted between the drive discs and the shaft to achieve the proper shaft extension ("G" dimension per SAE J620c). Holes are provided in the periphery of the

coupling discs, which correspond to tapped holes in the flywheel of the prime mover. The outside diameter of the drive discs fit in a rabbet in the flywheel so that concentricity is assured.

Grade 8 plated bolts and hardened washers are recommended to mount the drive discs to the flywheel. DO NOT USE SPLIT TYPE LOCK WASHERS**.** Split lock washers, when biting into the drive disc, cause stress risers, which may result in the disc fracturing.

The SAE flywheel housing adapter ring and the engine flywheel housing are designed to match each other with no further alignment necessary. Use grade 5 or greater mounting bolts. The feet should be shimmed where necessary to obtain solid contact with the sub-base. With the frame securely bolted to the engine flywheel housing, there is no side thrust or pull on the generator frame, thus there is no real need to secure the feet with more than one bolt per foot although multiple holes may have been provided.

NEVER "BAR OVER" THE ENGINE GENERATOR SET USING THE GENERATOR'S FAN. THE FAN IS NOT DESIGNED FOR THIS PURPOSE. BARRING OVER THE SET WITH THE FAN COULD DAMAGE THE FAN AND RESULT IN PERSONAL INJURY OR EQUIPMENT DAMAGE.

END PLAY TESTING

Refer to the engine manual for recommended endplay specifications and measurement procedures. If endplay is not to specification, it is an indication that the generator shaft is not moving freely in the assembly, and normal life of the thrust bearing could be impaired. Probable causes of this problem are:

1. Improper seating of drive discs in the flywheel resulting in misalignment.
2. Improper mating of generator frame to engine flywheel housing resulting in misalignment.
3. Improper "G" dimension per SAE J620c on either the engine or generator.

TORSIONAL VIBRATION

Torsional vibrations are generated in all rotating shaft systems. In some cases, the amplitude of these vibrations at critical speeds may cause damage to the generator, its driver, or both. It is therefore necessary to examine the torsional vibration effect on the entire rotating system.

IT IS THE RESPONSIBILITY OF THE GENERATOR SET ASSEMBLER TO ASSURE THE TORSIONAL COMPATIBILITY OF THE GENERATOR AND ITS DRIVER.

Drawings showing pertinent dimensions and weights of the rotating assembly will be supplied by Marathon Electric upon request.

OPERATION

PRE-START INSPECTION

WARNING

GENERATORS MAY HAVE VOLTAGE PRESENT AT THE LEAD TERMINALS WHEN THE SHAFT IS ROTATING. DO NOT PERMIT OPERATION OF THE GENERATOR UNTIL ALL LEADS HAVE BEEN CONNECTED AND INSULATED. FAILURE TO DO THIS MAY RESULT IN PERSONAL INJURY OR EQUIPMENT DAMAGE

Before starting the generator for the first time, the following inspection checks are recommended:

1. A visual inspection should be made for any loose parts, bad connections, or foreign materials.
2. Bar the set over by hand for at least 2 revolutions to be sure that there is no interference and that the set turns freely. If the set does not turn freely, check for clearance in the generator air gap.
3. Check all wiring against the proper connection diagrams, and ensure that all connections and terminations are tight and properly insulated.
4. Verify that all equipment is properly grounded (earthed). Follow all applicable NEC and local codes.
5. Clear the surrounding area of any materials that could be drawn into the generator.
6. Check all fasteners for tightness.
7. Check all access plates, covers, screens, and guards. If they have been removed for assembly or inspection, reinstall and check for security.
8. Review all prime mover prestart-up instructions, and ensure that all recommended steps and procedures have been followed.
9. Remove any masking materials affixed during painting. Inspect the generator, prime mover, and any accessory equipment to ensure that nameplates, all safety warning/ caution signs, and decals provided with the equipment are in place and clearly visible.
   Note: It is strongly recommended that the authority having jurisdiction over the installation site be consulted to determine if any additional warning or caution notices, or additional safety devices are required by local codes / standards. Any such required notices or devices should be installed prior to initial startup.

START-UP

The following procedure should be followed when starting the generator set for the first time:

1. The generator output must be disconnected from the load. Be sure that the main circuit breaker or fused disconnect is in the open position.
2. Verify that all prime mover start-up procedures have been followed.
3. If the unit is provided with space heaters, ensure that they are de-energized. In some installations, a set of auxiliary contacts on the main circuit breaker or transfer switch will automatically open the space heater circuit when the generator is connected to the load.
4. Start the prime mover and adjust it for proper speed (see generator nameplate).
5. The purpose of this initial test is to detect any wiring mistakes without exposing the unit to undue risk. Check all line-to-line and line-to-neutral voltages for balanced voltage. If voltages are unbalanced, shut down the equipment and check for improper wiring. If the problem persists, consult the factory.

WARNING

QUALIFIED ELECTRICAL PERSONNEL MUST CONDUCT THE FOLLOWING TEST. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE. CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

6. Monitor the generator output current to verify that it is at or below nameplate value.

SHUTDOWN PROCEDURE

There are no specific instructions for shutting down the generator; however, several good practices should be observed to prolong equipment life.

1. It is advisable to disconnect all loads (open main circuit breaker or disconnect) prior to shutdown.
2. Isolate all conditions that could apply voltage to the generator terminals while the generator is at rest. Failure to comply could result in personnel injury or equipment damage.
3. If the unit is equipped with space heaters, verify that the heater circuit is energized.

MAINTENANCE

The following maintenance procedures should be followed to ensure long equipment life and satisfactory performance. Maintenance intervals will depend upon operating conditions.

1. Routinely check intake and exhaust air screens to ensure that they are clean and free of debris. Clogged intake air screens will reduce cooling airflow and result in higher operating temperatures. This will reduce generator life and may result in generator damage.
2. All generators are equipped with ball bearings lubricated for the life of the bearing. Every 1,000 hours check the bearing(s) for smooth, quiet operation. For continuous duty generators, the recommended practice is to replace the bearing(s) during major overhauls of the engine.
3. Periodically inspect the unit for any buildup of contamination (dirt, oil, etc.) on the windings. If the wound components have become coated with heavy concentrations of oil and grime, the unit should be disassembled and thoroughly cleaned. This operation is not one that can be accomplished effectively on site, but rather one that should be conducted by an authorized service center equipped with the appropriate apparatus and solvents necessary to properly clean and dry the generator.

WARNING

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4. Monitor and record insulation resistance with a 500 volt megohm meter. The minimum acceptable reading is 2 megohms. If the reading drops below the minimum, the generator should be cleaned and dried at an authorized service shop. Consult Marathon Electric for more information.

DRYING WINDINGS

Generators in service may inadvertently have their windings exposed to splashing or sprayed water. Units that have been in transit or storage for long periods of time may be subjected to extreme temperature and moisture changes causing excessive condensation. Regardless of the source of moisture, wet windings should be thoroughly dried out before operating the unit. If this precaution is not taken, serious damage to the generator can result. The

following procedures may be utilized in drying the generator's windings. Winding wetness and situation limitations will influence the method selected.

Space Heaters
An electric heater may have been supplied with the generator. When energized from a power source other than the generator, the heater will gradually dry the generator. Enclosing the unit with covering and inserting additional heating units can accelerate this process. A hole should be left at the top of the covering to permit the escape of moisture. Care should be taken not to overheat various accessory equipment mounted with the generator.

Forced Air
Another method to dry the generator is to run the set with no excitation (see startup procedure item #2). The natural flow of ambient air through the generator will tend to dry the windings. This method can be accelerated by adding a source of heat at the air intake to the generator. Heat at point of entry should not exceed 80°C (176°F).

TESTING

Visual Inspection

Remove covers and look for any obvious problems: burnt windings, loose connections, broken wires, frayed insulation, cracked brackets, missing hardware, etc. Check for foreign objects that may have been drawn into the generator. Verify that the generator's air gaps are free from obstructions. If possible, rotate the generator manually to ensure free rotation. Never "bar over" the engine generator set using the generator fan.

WARNING

QUALIFIED ELECTRICAL PERSONNEL MUST CONDUCT THE FOLLOWING TEST. LETHAL VOLTAGE MAY BE PRESENT AT THE GENERATOR TERMINALS DURING THIS PROCEDURE. CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

Insulation Test

Insulation resistance is a measure of the integrity of the insulating materials that separate the electrical windings from the generator's steel core. This resistance can degrade over time or be degraded by contaminants: dust, dirt, oil, grease, and especially moisture. Most winding failures are due to a breakdown in the insulation system. In many cases, low insulation resistance is caused by moisture collected when the generator is shutdown.

Insulation resistance is measured with a megger (megohm meter). A megger measures insulation resistance by placing 500 volts between the winding and the frame of the generator. Caution must be taken to remove all electronic devices (regulators, diodes, surge protectors, capacitors, protective relays, etc.) from the winding circuit before checking the insulation. Minimum resistance is 2 megohms. If the winding resistance is low it must be dried (see maintenance section) or repaired.

SERVICE

The service procedures given in this section are those which can reasonably be conducted on-site with a minimum number of special tools and equipment. Qualified maintenance personnel should conduct all service procedures. Replacement parts may be ordered through an authorized service center or directly from the factory**.**

Bearing Removal

Opposite Drive End Bearing Bracket Removal
Remove the bearing bracket retaining bolts. Using a pair of screwdrivers, wedge the bracket off the frame. The bracket will clear the locating register on the frame and will drop until the rotor is resting on the main stator core. Continue to pull the bracket free from the bearing. Visually inspect the bearing bore and o-ring (if equipped) for damage or wear. If worn or damaged, repair or replace prior to reassembly.

Bearing Replacement
Using a bearing puller, remove the existing bearing. It is strongly recommended that the bearing be replaced any time it is removed from the shaft. **ALWAYS** install the same type and size bearing that was supplied as original equipment. Order by part number from the parts list, and include the unit serial number and part number when ordering. Heat the bearing to a maximum of 100°C (212°F) in an oven. Apply a thin coat of clean lubricating oil to the press-fit area of the rotor shaft. Using suitable heat resistant gloves, install the bearing over the end of the shaft until it seats against the shaft shoulder. The bearing should slide on the shaft and be seated without excessive force. Should the bearing bind on the shaft prior to being seated against the shoulder, a piece of tubing slightly larger than the press fit area can be used to drive the bearing to its final position. Using light taps with a soft mallet, apply pressure to the inner race only.

RETURNED GOODS

Contact Marathon Electric Manufacturing Corporation for authorization before returning any product. We cannot be responsible for any items returned without authorization.

CAUTION

Single bearing generators must have their rotor assembly properly secured to prevent damage during transit to the factory or to an authorized service center.

TROUBLESHOOTING

This section is intended to suggest a systematic approach to locating and correcting generator malfunctions. The section is arranged according to the symptoms of the problem. The steps have been arranged in an attempt to do the easy checks first and prevent further damage when troubleshooting a disabled machine.

The first step of troubleshooting is to gather as much information as is possible from operating personnel and individuals present during the failure. Typical information includes how long the unit had been operating, what loads were on line, weather conditions, and protective equipment that did or did not function. In addition, information as to the operating condition of the generator's prime mover is vital. Has the prime mover been maintaining constant speed? If not, have there been extended periods of underspeed operation? Has the prime mover experienced an overspeed condition? If yes, what was the maximum speed, and how long did the unit operate at that elevated speed?

CAUTION

1. **Do not perform any maintenance or service on this generator before disconnecting the power source.**
2. **Discharge all capacitors before servicing the generator.**
3. **Always keep hands and clothing away from moving parts.**
4. **Trained and qualified personnel should perform electrical repairs.**
5. **Failure to follow instructions and safe electrical procedures could result in serious injury.**
6. **Be sure that all safety guards are in place.**

TROUBLE	CAUSE	CHECK AND REMEDY
Wrong rotation	Wrong sequence of phases	Reverse connections of two phases.
Generator overheats while running under load	Generator is overloaded	Reduce load. Check with ammeter and compare with nameplate rating.
	Clogged ventilating screens	Clean air passages.
	High room temperature or altitude	Improve ventilation or reduce load.
	Insufficient circulation of cooling air	Generator location and enclosure design must provide adequate airflow and minimize recirculation of hot air.
	Unbalanced load	The load on each leg should be as evenly balanced as possible and should not exceed rated current on any one leg.
	Open phase or grounded coil	Check for faulty leads and connections. Check winding resistance.
Generator vibrates	Generator misaligned	Realign.
	Defective bearing	Replace bearing.
	Balance weights shifted	Check and rebalance generator rotor.
	Generator running on single phase	Check for proper connection/loads.
	Excessive endplay	Adjust or repair.
Unbalanced line current during normal operation	Unequal terminal voltage	Check leads and connections; check excitation source.
	Single phase operation	Check for balanced loads or open circuit.
Scraping noise	Foreign body in air gap	Check and clean generator interior.
	Fan rubbing	Check for interference and adjust.
	Bad bearing	Check bearing and replace.
	Generator loose on bed plate	Check for movement and tighten mounting.
Noisy operation: "humming" and/or "pulsating"	Air gap not uniform	Check and adjust mounting.
	Rotor unbalance	Rebalance rotor.
	Low voltage	Check voltage and frequency per nameplate and instructions provided in manual.
	Loads not balanced on phases	Check and redistribute loading.
Hot bearings	Overloaded bearing	Check end play and adjust.
	Misalignment	Check mounting and adjust as needed. Check bearing bracket for correct assembly.
	Lubricant has failed	Regrease or replace bearing.
	Bearing worn or defective balls	Replace bearing.
	Bent shaft	Straighten or replace.

This manual is printed on recycled paper because we at Marathon Electric share your concern for our environment.

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